Physics 8048
Problem Set 1, due 9/17/14
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1. For the theory:

$$\mathcal{L} = i\bar{\Psi}\gamma^\mu\partial_\mu\Psi - m\bar{\Psi}\Psi - \frac{1}{2}\partial_\mu\phi\partial^\mu\phi - \frac{1}{2}M^2\phi^2 + g\phi\bar{\Psi}\Psi\,, \tag{1}$$

show explicitly that $e^-\phi \to e^+\phi$ has zero tree amplitude

2. For the same theory (eq. 1), deduce the tree amplitude for $e^+e^- \to e^+e^-$ by following the Feynman rules. The amplitude can be found in Srednicki eq. 45.25. Justify why there has to be a relative minus sign between the two terms.

3. We have more or less covered everything up to Chapter 45 of Srednicki in the class. Please read Chapters 46 - 48 on your own. As an exercise, verify Srednick's eqs. (47.20) and (47.21). Note that the factors of d come from having d dimensions i.e. in anticipation of dim-reg, we assume there are d different γ^μ's implicitly, such that for instance $\{\gamma^\mu, \gamma_\mu\} = -2\eta^\mu{}_\mu = -2d \times I$ for instance. But we continue to pretend γ^μ and I are 4×4 matrices. This might seem odd to you – and it is – but somehow the claim is that it works, as can be checked by consistency with other regularization methods.